PROGRESS REPORTS

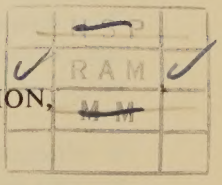
FROM

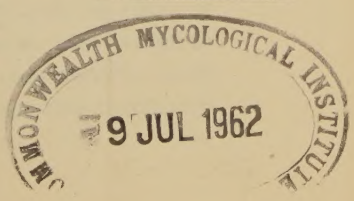
EXPERIMENT STATIONS

SEASON 1960-61

NORTHERN NIGERIA

PUBLISHED BY
THE EMPIRE COTTON GROWING CORPORATION,
12 CHANTREY HOUSE, ECCLESTON STREET,
LONDON, S.W.1.
Editor: H. E. King, O.B.E.
1962





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SAMARU, ZARIA PROVINCE

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NORTHERN NIGERIA

PROGRESS REPORT FOR THE SEASON 1960-61

Sowing period: June to September.
Picking period: November to March.
Close season: April to June.

General Introduction

BY

J. M. MUNRO

The Nigerian Cotton Crop

This has been a very successful year for cotton in Northern Nigeria; the crop of 290,984 bales of lint exceeded the previous record of 1957-58 by over 50,000 bales. Two provinces—Katsina and Sokoto— have, for many years, been the largest producers of cotton, but it is noteworthy that this year they had rather less favourable conditions, and were the only ones to produce less than in 1957-58. The newer cotton areas, particularly Bauchi Province where the Gombe and Kumo ginneries are situated, have gone ahead fast, and it seems likely that future production will fall little short of 200,000 bales, even in a relatively bad year.

Over most of the country early rains in May and June were good, and food crops were established early; there was therefore no obstacle to timely sowing of cotton, and the years of propaganda for early sowing were able to show results.

Rainfall in August and September in Zaria and Katsina was good; elsewhere it was adequate. In all areas, the onset of harmattan conditions was later than usual, which undoubtedly helped the later sown cotton to produce a reasonable crop.

Interest in cotton in Bauchi, Bornu and Adamawa provinces continues to expand, and a larger acreage was sown. Even with the opening of the new ginnery at Lamurde, west of Numan in Adamawa province, the ginneries at Gombe and Kumo worked to full capacity.

Half of the cotton seed issued to growers in 1960 was treated with Agrosan 5W to reduce the amount of seed-borne bacterial blight; the effect of this is diffcult to assess, but it made its contribution to higher yields per acre.

The variety Samaru 26J replaced Samaru 26C over the remainder of the region. It was also issued in the Lokoja ginnery area in place of Benue seed; it was accepted in most districts, but some still prefer to grow Benue cotton. The latter is preferred by the considerable hand spinning and weaving industry, and some growers are not convinced that 26J gives as high a yield in this area.

Small-scale trials with Samaru 26J continued in Western Nigeria with encouraging results, and 600 lb of seed was supplied by the Northern Region Marketing Board for extended trials in 1961-62. All trials are sprayed with insecticide, and under these conditions, this *G. hirsutum* strain has, in most cases, outyielded the local Ishan cotton (*G. barbadense*).

Experimental Work

This report discusses the strains which went into Samaru 26J, and the possibility of making a new seed issue from Samaru.

Selection in S52 and S56 by various methods has continued, with special attention to correlation between the measured characters. The 1954 crosses have not produced anything of special value, and a new hybridization programme is being started.

There was an unusually high level of bacterial blight at Samaru this season. Records of natural infection enabled all the current material to be graded for resistance; these records gave a lower coefficient of variation than any of the artificial inoculation methods. Liquid seed dressings gave an acceptable level of control, not differing significantly from the standard dressing with Agrosan dust. Cotton seed samples from Bauchi province were again more heavily infested than seed from other parts of the region.

The structure of the pupal cell of red bollworm, and the characteristics of an important parasite of this pest, have been studied in some detail. Control of insect pests allows much of the potential yield of cotton sown early in June to be realized; extension trials of cotton spraying in the provinces showed an average increase, due to spraying, of 300 lb of seed cotton per acre, showing a profit of £3 per acre.

Staff, Buildings and Land

There were no changes in senior staff during the 1960-61 season; subsequent changes are shown in the staff list.

Work was started in March 1961 on the building of a new office and laboratory block. An old store and garage near the cotton laboratory and ginnery has been enlarged and improved for use as a cotton store.

Dry season cultivation of the experimental farm is now possible with more powerful tractors and appropriate implements. A regular cycle of subsoil cultivation every three years preceding the cotton crop in the rotation has been started. Ridges are now partially split while still dry to allow the first rains to penetrate the centre of the ridge; this has allowed direct splitting of the ridges to replace the sequence of ploughing, cultivation and ridging, previously carried out after the rains had started.

TABLE 1

SUMMARY OF METEOROLOGICAL DATA AT SAMARU, 1960

Latitude 11° 12′ N, longitude 7° 37′ E, altitude 2,210 feet above sea level

Month	*Rainfall (inches)*		*Days rain*		*Relative humidity %*				*Air Temperature °F (screen)*				*Sunshine daily mean (hours) (1)*		*Open pan evaporation (inches) (2)*	
		Average 1924 to 1960		Average 1938 to 1960	1960		Average 1954 to 1960		1960		Average 1938 to 1960			Average 1954 to 1960		Average 1954 to 1960
	1960		1960		10·00 hours	16·00 hours	10·00 hours	16·00 hours	max.	min.	max.	min.	1960		1960	
Jan.	0·00	0·00	0	0·1	14.5	11.0	19.8	15.8	85·7	56·2	88·1	57·6	8·4	9·0	7·31	7·21
Feb.	0·00	0·06	0	0·3	6·8	6·0	15·8	11·3	89·3	60·3	91·3	60·6	10·3	9·6	9·21	8·00
Mar.	0·00	0·37	0	1·0	23·8	10·8	29·5	16·3	95·0	65·6	96·0	67·2	9·5	9·0	8·91	8·88
April	2·09	1·32	9	3·7	60·4	40·0	54·3	31·3	93·2	70·6	97·0	71·1	7·6	7·9	7·19	7·39
May	2·17	5·24	6	10·7	59·0	34·8	64·0	43·7	93·6	69·3	91·8	70·0	8·5	8·4	7·81	7·13
June	7·21	6·37	16	13·0	67·7	52·9	74·9	59·9	87·7	67·1	87·8	68·0	8·8	8·0	6·73	5·77
July	8·24	8·70	17	15·9	79·5	67·6	79·9	67·7	82·3	66·4	83·4	67·2	5·9	5·9	5·14	5·03
Aug.	9·66	11·57	19	20·4	77·5	66·4	82·5	70·8	83·7	66·8	82·0	66·9	6·8	5·0	5·45	4·45
Sept.	13·35	9·07	20	16·9	74·6	62·0	76·8	64·0	84·9	66·1	84·8	66·6	6·5	6·6	5·70	5·10
Oct.	0·25	1·43	4	4·6	66·1	45·9	61·0	44·8	88·2	66·0	88·9	65·2	8·8	8·9	4·93	5·61
Nov.	0·00	0·04	0	0·2	26·1	19·1	32·7	21·1	87·1	58·6	90·1	60·6	9·4	9·9	6·46	6·31
Dec.	0·00	0·00	0	0·0	26·2	18·9	23·6	17·6	88·8	59·3	87·9	57·8	8·7	9·6	6·17	6·72
Totals	42·97	44·17	91	86·8	—	—	—	—	—	—	—	—	—	—	81·01	77·60
Means	—	—	—	—	48·5	36·3	51·2	38·7	88·3	64·4	89·1	64·9	8·3	8·2	6·75	6·47

(1) Campbell-Stokes sunshine recorder.

(2) From sunken tank 6 ft × 6 ft; not corrected for errors due to splash.

Plant Breeding

BY

J. M. MUNRO, B. J. S. LEE AND B. E. COSTELLOE

Variety Trials

Samaru 26J New Blend was issued for multiplication in 1957-58, and contained eleven of the latest selections from the three families of the original 26J. In trials in which the two issues have appeared together, the New Blend has given an average of 6 lb per acre more lint than the first wave. It also has a better yield record over five seasons than the individual selections which went into the mixture: all but three of these have since been discarded for various reasons, and of these three, two which were in the district variety trials this season gave the lowest yields among the eight varieties tested.

A new seed issue to replace 26J is therefore being considered, as there are several new strains showing improvement in various characters. Two trial mixtures, QA and QB, have been made up and will be tested at Samaru and in the district trials in 1961-62.

QA contains derivatives of the two families discussed last year, one high yielding (S56 ex S48) and one of good spinning quality (ex S49). The second mixture, QB, contains six strains all slightly better in one way or another than 26J. A summary of their yield and other characters is given in Table 2.

Table 2

Strain characters relative to Samaru 26J

The symbol ++ indicates marked superiority; +, less marked; o, no conspicuous difference; −, some inferiority.

Family	*Strain*	*Mixture*	*Yield* 1956 to 1960	*Spinning* 1956 to 1959	*Resistance to:* Jassid	*B. blight*	*Seed weight*
S56	5/44	QA+QB	++	o	+	+	o
(S48)	7/13	QB	++	−	−	++	++
S49	7/12	QB	+	o	o	+	o
	7/21	QB	+	o	o	+	+
	7/36	QA	o	++	o	++	−
S52	5/88	QB	o	+	+	o	+
	8/8	QB	+	+	++	o	+

S52 Selections—Selections Index

The use of the selection index technique was continued for a fifth year in the analysis of, and selection within, the progeny rows. This year the family S52 occupied the complete trial. Progenies were included which had been selected on yield alone (rejected on last season's index) and others which had been chosen solely on their high index values. No conclusive results were obtained in favour of either

method of selection—see Table 3. Derivatives from both sources are being carried forward.

TABLE 3

RANK ORDER OF PROGENIES BASED ON ADJUSTED LINT YIELD AND SELECTION INDEX WITHIN FAMILY S52

Rank order is for first twenty-five places only; that for selection index is given in brackets

Season:	*1957-58*	*1958-59*	*1959-60*	*1960-61*
No. of progenies:	12	32	41	44
Strain 6/5	1 (1)	1 (1)*	2 (3)	2 (6)
		2 (2)	6 (9)	32 (12)
		5 (4)	13 (4)	1 (1)
		6 (11)	12 (24)	6 (9)
	3 (4)	3 (3)	3 (16)	7 (3)
		8 (21)	13 (17)	8 (5)
		11 (15)	4 (6)	25 (16)
		12 (7)	7 ( )	33 (25)
	4 (2)	20 (10)		
			4 (7)	36 (20)
	2 (3)	4 (5)	18 (13)	37 (18)
		7 (8)*	13 (5)	10 (10)
Strain 6/8		9 (12)	21 (19)	12 (7)
	8 (6)	10 (9)		
	7 (7)	13 (6)	1 (2)	9 (22)
	10 (12)	15 (13)	7 (8)	26 (13)
	12 (8)	17 (18)	7 (1)	4 (2)
		19 (17)	17 (10)	16 (8)

*Progenies carried forward, but discarded the following season.

The need for more than one control in an experiment was clearly demonstrated this season. In the progeny row trial described above, two of the forty-nine treatments were 26J. These two controls had significantly different (5% level) seed cotton yields and were 6th and 44th on rank order.

S56 Selections—Modal Bulk

Following the procedure described in the Progress Report for 1959-60, page 6, a modal bulk and a positive bulk were made up and tested in replicated trials. No difference could be shown between them despite the considerable differences in selection pressure.

Plants from these bulks were selected in the field, analysed and screened to give further bulks for continuing this study.

S56 Selections—Special Character Bulks

Five special character bulks were grown and analysed in continuation of work recorded in last season's report. In the first year that these bulks were grown (1959-60 season) no significant differences could be demonstrated between the means of the

contrasted characters, seed weight and number of seeds per boll. This year both pairs differed at the 0·1% level of probability. The bulk for high lint per seed was significantly different (1% level) both this season and last from the mean of the four remaining bulks for this character, confirming its known high heritability. The bulks for high and low seed weight are to be tested for yield in the coming season.

S56 Selections—Special Character Progenies

Progenies selected for improved ginning percentage, high lint yield and improved halo length were again grown in a replicated trial. After three generations it is proposed to change the character on which selection has been previously based, viz. to proceed to the second stage of the tandem selection programme. Table 4 shows the measure of success achieved with each set of progenies.

Parent with progeny and progeny with progeny correlations were calculated for the three characters. Ginning percentage appeared highly heritable; yield and halo length appreciably less so. Halo length was shown to be negatively correlated with ginning percentage and also with lint yield.

TABLE 4

EFFECT OF SELECTION ON SEED COTTON CHARACTERS

Group I: selected for improved ginning percentage.
Group II: selected for high lint yield per plant.
Group III: selected for improved halo length.

Character	*Group*	*1958-59*		*1959-60*		*1960-61*	
		Bulk	*Selections*	*Trial*	*Selections*	*Trial*	*Selections*
Gin %	I	36·9	40·1	36·1	36·7	37·0	38·2
	II		37·0	35·7	35·9	36·2	35·9
	III		35·6	34·0	33·5	34·0	34·1
Lint yield (g)	I	38·8	45·2	27·0	27·9	40·3	45·2
	II		76·4	27·2	29·9	41·1	43·3
	III		41·1	23·9	25·7	35·5	36·5
Halo length (mm)	I	33·9	33·9	31·5	31·4	32·4	32·5
	II		34·4	31·6	31·7	33·0	32·7
	III		37·5	32·8	33·8	34·3	35·0

Correlations between seed cotton characters at Samaru and elsewhere have been summarised. It has been shown that certain correlations are consistent over a wide range of conditions, and can be used as an aid in cotton selection. It is intended to publish this work separately.

Hybridisation

Further reductions were made in the number of hybrids carried forward from those made in 1954 (see Progress Report for 1959-60, page 7).

Three crosses from the 1959-60 trial were grown in the 1960-61 strains test. Only one of these, derived from the 26I × BAR D28 material, has been retained. Fourteen single plant selections kept from 1959-60 were grown in an unreplicated trial because of shortage of seed. These were analysed on the basis of field and laboratory characters. Four were of sufficient merit to warrant further study, and these will be included in the 1961-62 strains test.

The annual panmixis bulks were grown again at Gusau, Gombe, Kontagora and Samaru, as outlined in last season's Progress Report. Two progenies from single plant selections made from the Samaru panmixis in 1957 were tested this year. One of these was carried forward since it gave the top yield in the strains test; the ginning percentage was also higher than that of 26J.

Work was continued towards producing a glandless cotton with the field characters of 26J. This has now reached the stage when it can be used in trials to measure the amount of natural outcrossing at Samaru. This information will be of use in judging the degree of isolation necessary in order to maintain pure line cotton bulks without hand selfing.

A small number of hand pollinations were made between the two strains forming the QA bulk (mentioned earlier) and between 26J and imported strains.

Seed Cotton Characteristics

Advantage was taken of the entomologists' sowing date trial and one of the physiologist's agronomy trials to investigate the changes through the season in the values of seed cotton per boll, ginning percentage, seed weight, seeds per boll, lint per seed and halo length under each of the various treatments. It is hoped to publish these results in full elsewhere.

Seed Types

Samaru 26J seed contains a range of types from tufted to fully fuzzed and of fuzz colours from white to green. Samples of types within this range have been separated out, and populations from these will be grown and studied next season.

Crop Physiology

BY

D. A. LAWES

Maximum Yield Plots

This season a new set of "maximum yield" plots was laid down on a new site; three plots of approximately 1½ acres each are to be

rotated with the Samaru rotation of cotton, sorghum, groundnuts. These plots have been laid down with the intention of repeating on a different site, and on a larger scale, the highly successful results already obtained with cotton on one small plot, and of examining the effects of similar treatments on the other two major crops of the area.

Present indications are that although the same principles apply to these other crops, such spectacular results as those obtained with cotton are unlikely. The necessity for adequate soil moisture is clear enough, but the pattern of growth and apparently low susceptibility of these two crops to poor soil aeration are dissimilar to cotton.

The original maximum yield plot of cotton described in previous reports gave 2,540 lb seed cotton per acre this year. This is the "highest ever" yield and appears to indicate that the "fertility" of this plot is tending to improve rather than deteriorate; it is suggested that a good crop of cotton may well improve fertility under the local conditions. These good cotton crops root down to a depth of more than six feet, whereas average crops rarely go beyond three feet. At the end of the season the cotton plants are "uprooted", but this only means that the tap root is broken off some three to nine inches below ground surface; the remainder of the root system is left in the soil where it eventually decomposes, adding a small amount of organic matter to the profile and also leaving channels for soil water movement and soil aeration, which have been shown to be so important on these soils. In addition to this, the heavy leaf fall from a strongly growing crop is perhaps a valuable contribution to the topsoil. It therefore seems reasonable to suggest that a good cotton crop may improve the fertility and depth of the profile available for future crops.

The yield of cotton on the new plot was 1,937 lb of seed cotton per acre, although subplot figures from within this area ranged from 1,757 to 2,275 lb per acre. These figures compare with the plots having identical treatment in a cultivation experiment (described later—Table 5) which gave 2,023 lb seed cotton per acre. The inference that a crop of near 2,000 lb per acre can be grown almost to order in any season may make it possible to evaluate quite closely the costs and returns to be expected from the various treatments which are used to produce such a crop. Next season's programme has been designed with this in mind.

The maximum yield plots of sorghum and groundnuts were given the same manurial and cultural treatments as the cotton plot; the sorghum was sprayed against stem borers (*Busseola fusca*); no organic manure was applied to the groundnuts.

The sorghum gave a yield of 3,381 lb grain per acre; this was a good but not an oustanding yield for the variety Short Kaura.

The groundnuts exhibited very vigorous growth, but the yield of nuts was not as good as expected from the size of haulm; the yield of 1,400 lb kernels per acre was good for Samaru, though not exceptional.

A complete trace element mixture was applied to a strip running across the plots of all three crops to observe whether some deficiency may be incurred at these high levels of farming, but no increases in growth or yield were detected.

Replicated Trials

Replicated trials testing the effects of different cultivation treatments were carried out independently on the three crops. It is intended to write up the results of the experiments on sorghum and groundnuts elsewhere. On cotton, cultivation treatments which set up differences in rainfall retention and soil aeration were this season compared at two levels of fertility. The results are given in Table 5; the whole experiment was sprayed with insecticide eight times, at weekly intervals; the vertical mulching consisted of filling a vertical slit in the furrow bottom with groundnut shells.

With adequate rainfall this season, a good crop was obtained from the control treatment where rainfall had not been conserved. Where infiltration had not been improved, standing water in the crosstied furrows depressed yields; this depressing effect was removed at the high fertility level, and reduced at the low fertility level, by leaving alternate furrows open. It is of interest that the effect of crosstying alternate furrows has not been enhanced by the addition of vertical mulching between crossties; it appears that the alternate free-draining furrows have allowed adequate soil aeration.

Two new ideas about the effects of standing water on cotton have emerged from this season's work. An experiment carried out by the entomologist (see Table 7), and a date of sowing × population × fertility experiment briefly discussed later, both indicate that the effect of standing water on cotton varies greatly according to its stage of growth at the time. Cotton sown in the first week of June was not depressed by the wet soil conditions in late August and September; by that time it was sufficiently well advanced to withstand these conditions. These experiments, though fully crosstied, yielded 1,939 and 1,900 lb per acre respectively, which compares with the highest yield quoted above.

A high level of fertility may possibly help in the same way, the stronger growth being better able to withstand the conditions.

Crosstying the ridges ensures even distribution of rainfall and thus soil moisture over the field. In the absence of crossties, surface water flow will cause the higher areas to lose rainfall to the depressions; such uneven distribution can cause uneven growth. An experiment

with long plots running across minor undulations (agriculturally flat land) showed that variation within plots was higher for those where surface water flow was uncontrolled. Even though crosstying all furrows may sometimes cause a uniform depression in growth, it is important to prevent avoidable within-plot variation in all types of field experiments.

TABLE 5

CROSSTYING, SLITTING THE FURROW BOTTOM AND VERTICAL MULCHING

Crosstying treatment	*Furrow bottom treatment*	*Yield of seed cotton (lb per acre)* *High fertility* (1)	*Low fertility* (2)
All furrows	None	1529	842
	Slit only	1698	948
	Vertically mulched	2023	1327
Alternate furrows only	None	1844	1120
	Vertically mulched (crosstied furrows only)	1773	1077
None	None	1851	1218
S.E. of cultivation treatments		±51·5	

(1) *High fertility*:

2 tons per acre night soil compost.
160 lb per acre single superphosphate.
80 lb per acre sulphate of ammonia.

(2) *Low fertility*:

80 lb per acre single superphosphate.

Plant Population

Past experiments (Progress Reports from Experiment Stations, Northern Nigeria, 1952-55) have indicated that within limits, plant population does not influence yield. Similar yields have been obtained from spacings ranging from nine inches to thirty-six inches along three-foot ridges. The yield levels of these experiments were always low to medium by present standards, and it was considered that the question must be re-investigated at the high yield levels now possible. An experiment was designed comparing five plant populations under two levels of fertility and with rainfall conserved; unfortunately it was not possible to ensure rapid rainfall infiltration by any additional technique and the whole experiment underwent periods of surface flooding. However, the yields obtained suggest that a higher population than that at present used may give increased yields at these high levels of fertility. It is intended to repeat this experiment next season with mulching to obtain additional data on yield, the pattern of leaf area development and peak leaf area index.

The Value of Cotton Plant Ash as a Source of Plant Nutrients

As a crop sanitation measure, after harvest all cotton plants are uprooted or cut off just below ground surface level and burnt. To

burn satisfactorily, the stalks must be gathered into heaps, giving irregular patches of ash; these patches are undesirable on experimental fields, and the stalks have previously been carried off and burnt elsewhere; the ash was therefore wasted.

The stalks from approximately twenty acres were collected and spread evenly in bundles over experimental plots totalling just over an acre. These were burnt during late April and the land lightly cultivated to settle the ash and prevent it blowing away. The land was then cultivated and sown with cotton in the usual way.

Analysis of samples of the ash gave the comparable dressings of phosphate, potash and magnesium as:

51 lb per acre single superphosphate
20 lb per acre KCl
and
326 lb per acre magnesium sulphate

The yields of seed cotton in lb per acre were as follows:

dressing of cotton plant ash	1,081	
nil dressing	669	
difference	412	±72·6

Breaking of Surface Pan in Old Furrow Bottom before Splitting Ridges

The standard method of land preparation prior to sowing crops is to split the old ridges over the furrows, which may be severely capped from the previous season's rainfall. An experiment was laid down to investigate whether any hindrance this hard layer may have on root development of the following crop may be discernible in final yield. On the site chosen for the experiment, no difference in growth could be observed and there was no significant difference in final seed cotton yield.

The breaking of this old furrow pan with a cultivator in the dry season is an exceedingly difficult and expensive operation; it is fortunate that it does not appear to form a permanent barrier to cotton plant development.

Plant Pathology

BY

M. DRANSFIELD

There was a very high level of bacterial blight this season, bolls being exceptionally heavily infected. Other diseases were not important.

Seed Dressings

Five mercurial dust dressings and two liquid mercurials (Agrosol and Panogen) were compared with Agrosan 5W on heavily infested 26J seed. All dressings gave an acceptable control of blight, none being significantly different from Agrosan. Of the liquid dressings, Agrosol gave significantly better control than Panogen (significant at P=5%).

The manufacturers' recommended rates of applying both Panogen and Agrosol is 1:350 v/w. On Nigerian fully-fuzzed seed this low rate gives what appears to be a very inefficient coverage; the fuzz is very sparsely and irregularly covered with the dressing, with apparently none on the seed coat. Agrosol and Panogen were therefore compared with each other at four rates between 1:150 and 1:400 to check whether the higher rates were more efficient in controlling bacterial blight. Agrosol was slightly phytotoxic at the highest rate. There was a tendency for the 1:150 rates of both dressings to give a lower level of infection (0·2% as compared to a mean of 0·7% for the other rates) but this was not significant.

The liquid dressings (1:350) were also compared with Agrosan dust (1:150) to test the possibility that any internal infection remaining after acid treatment, which is not controlled by the vapour of dust preparations, might be affected by the more volatile liquids, but this proved not to be so. None of the dressings gave any further significant reduction in the percentage of infected plants.

Loads of mercury between 50 and 350 p.p.m. were applied, using Agrosan which was specially formulated to contain 1, 3 or 5% mercury. Any load below 300 p.p.m. (the current dressing) gave poor disease control, but it is not impossible that better control might result from using rates above 350 p.p.m. Whether this would be economic is unknown; next season rates up to 500 p.p.m. will be tried. A further experiment showed that it was the actual load of mercury on the seed, rather than its concentration in the dust, that was the deciding factor in blight control.

Samples of dressed seed from the Plantector dressers at Funtua ginnery were tested by agar plate assay. Both machines produced an evenly dressed sample at the required rate of 1:160, provided that the amount of Agrosan in the hopper was not allowed to fall below 14 lb.

Bacterial Blight

Seed inoculation, although very effective in the field in producing heavily infested plants, gave unreliable results in the greenhouse, where the wrong combination of sunlight, temperature and humidity generally led to few or no blight symptoms.

Field inoculations by spraying suspensions of cultures, by stem inoculation and by boll inoculation, were again unsuccessful despite a variety of plant ages, concentrations of inoculum, times of day and variations of technique. Inoculations of young seedlings below the cotyledons, or the first leaf, produced vascular symptoms in the first three or four leaves, but no stem symptoms.

Mid-vein leaf inoculations in the field continued to give moderate results, but the ages of the plant and of the leaf are both most critical. Plants between five and seven weeks old give the largest lesions, and the most susceptible leaves are the two immediately below the topmost fully expanded leaf.

All the strains tests and progeny row trials were leaf inoculated; in addition, natural infection of these, and of the early and late sown district variety trials at Samaru, was recorded. The number of diseased plants and also the mean grade (using Knight's 0 to 10 scale) were used. Records of natural infection gave a lower coefficient of variation than vein lesion records, which suggests that inoculation methods which produce a natural disease picture (without the necessity for wounding the plant) are preferable in this country for determining blight resistance. It was also easier to pick out the more susceptible plants than the resistant ones, although no plants outstanding for either resistance or susceptibility were found this season.

The routine growing of seed from market samples, now in its fourth season, keeps a check on seed infestation in the Region. Seed from Bauchi Province, and from adjoining areas of neighbouring Provinces, was again consistently more heavily infested than seed from other parts of the Region. It is too early to say whether the use of dressed seed in sowing the Funtua ginnery area is having any decided effect on the amount of infestation of the seed produced there.

The influence of date of sowing on bacterial blight incidence was investigated on the entomologists' date-of-sowing trial. Plants from weekly sowings between 3rd June and 22nd July were examined when 40 days old; the greatest amount of infection was present on the 1st and 8th July sowings, significantly so ($P = 0{\cdot}1\%$) over all other sowings except that on 15th July.

In three experiments in which large quantities of fertilizers and/or organic manure resulted in large, succulent plants, the level of infection was much higher than in plants grown at lower fertility levels.

The spread of bacterial blight from a focus of infection (as used by Last in the Sudan) was tested with a view to using it in Nigeria for testing the ability of any strain to withstand natural infection. As expected, close spacing increased the rate of spread within the plot; a 12×12 yard plot of 26J was completely infected seven weeks after sowing with 6 inch $\times$ 1 yard spacing, but only 80% infected at 12

weeks with 1 yard × 1 yard spacing. Spread was slower in the resistant Maradi B, but more rapid in the susceptible Punjab 268F, than in 26J.

Other Diseases

About 0·01% of the seedlings were killed by collar rot or damping off in the strains test; the predominant fungi isolated were *Rhizoctonia* (*Corticium*) *solani, Pythium* sp. and *Fusarium* spp., mainly *F. oxysporum*. In the maximum yield plot, about 4% of the seedlings were affected with stem break (compared with 5% last season). *R. solani* and *Sclerotium rolfsii* were consistently isolated from diseased plants, and experiments next season will investigate the role played by each species. This disease continued to affect plants up to 7 weeks after sowing; older plants appeared resistant. Only three other plants in the whole cotton area were found with this disease, which appears to be associated with continuous cropping combined with high fertility.

One plant of 26J grown in a pot among forty other pots of the same variety became infected with very pronounced leaf curl symptoms. Seed from this plant will be sown next season to see if these symptoms recur.

Routine observations and records were again made on *Alternaria, Ramularia* and *Cercospora*. There were no significant differences this season between strains.

In co-operation with the general plant pathologist, a detailed qualitative and quantitative investigation of the soil microflora was made on plots which had carried cotton, guinea corn and groundnuts, both as monocrops and in rotation, with and without farmyard manure. Detailed results will be published elsewhere on the effect on the rhizosphere of monocropping of all three crops. No build-up of any pathogenic soil organism was observed for any crop, although a special technique for isolation of *Rhizoctonia solani* will have to be used next season.

Entomology

BY

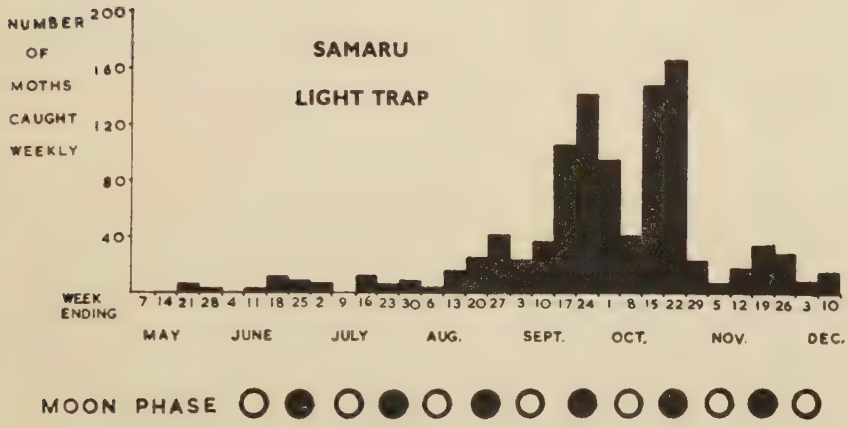
M. A. CHOYCE AND W. REED

Cotton Pests in 1960—General Notes

The heavy cotton crop of 1960-61 was primarily due to favourable weather conditions combined with more general early sowing, rather than to any marked reduction in pest infestation. The incidence of the important pests, *Diparopsis watersi* (Roths.) and *Dysdercus*

FIGURE 1

INCIDENCE OF *Diparopsis watersi* (1960)


NUMBER OF MOTHS CAUGHT WEEKLY
200
160
120
80
40
SAMARU
LIGHT TRAP
WEEK ENDING
7 14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10
MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
MOON PHASE
NUMBER OF MOTHS CAUGHT WEEKLY
160
120
80
40
DAUDAWA
LIGHT TRAP
WEEK ENDING
7 14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10
MAY JUNE JULY AUG. SEPT OCT NOV DEC.
NUMBER OF MOTHS EMERGED WEEKLY
100
80
60
40
20
SAMARU
DIAPAUSE EMERGENCE
FROM TROUGHS
WEEK ENDING
7 14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10
MAY JUNE JULY AUG SEPT OCT NOV DEC

superstitiosus (F.) was much as usual, but the leaf roller, *Sylepta derogata* (F.) was again particularly severe in several areas, though it was in most cases quickly controlled by parasites. The red spider mite, *Oligonychus gossypii* (Zacher) was of no importance on either sprayed or unsprayed cotton. At Samaru, the cotton aphid, *Aphis gossypii* (Glov.), multiplied rapidly late in the season on sprayed cotton. Damage in the form of sticky lint was slight, as picking was almost completed.

Emergence from Diapause and Time of Flight of Diparopsis watersi

Light trap records on the red bollworm were continued throughout the season. At Samaru, a Robinson trap, incorporating a 125 watt mercury vapour lamp, replaced the 100 watt filament bulb; a Tilley storm lantern was again used at Daudawa. Figure 1 shows the number of moths caught per week at the two stations, together with the weekly totals of moths emerging from pupation troughs at Samaru. The reduction in the numbers of moths coming to the lights in periods of moonlight was again quite marked. At Samaru and Daudawa the main moth flight occurred during the six weeks following mid September. Maximum emergence from long-term pupae in the troughs occurred two to three weeks later than in 1959 (cf. Figure 1 in Progress Report for 1959-60).

The structure and physical properties of the earthen cell which encloses the pupa of *Diparopsis* have been examined. A porous area in the wall of the cell has been described, and a pronounced reduction in the porosity of the cell to air, when it is wet, has been demonstrated. If it is accepted that the rate of diapause development is affected by the oxygen supply to the pupa, it becomes obvious that the structure and function of the cell are intimately concerned in the biology of the insect (Choyce and Reed, 1961b).

The value of the parasite *Carcelia evolans* (Wied.) in the control of the red bollworm is greater than previously believed. New determinations of the rate of parasitism, made on multiplication cotton at Daudawa and Shemi, are given in Table 6. Collections of fifth instar larvae were made on sprayed and unsprayed cotton, and allowed to pupate in dry soil. The number of parasites was obtained in the laboratory from emergence of moths and flies, and from dissection of pupal cells from which no emergence had taken place. The low rate of parasitism (16%) for the November collection of bollworms at Daudawa may have been caused by the application of insecticide earlier in the season, since it is to be expected that the parasite is easier to kill than its host.

TABLE 6

PROPORTION OF *D. watersi* PUPAE PARASITIZED BY *Carcelia evolans*, 1959-60

	Date of collection of 5th instar larvae	*Number of pupal cells set*	*Percentage of parasitized pupal cells*
From sprayed cotton at Daudawa	13 Nov.-28 Nov.	1002	16·0
	29 Nov.-24 Dec.	674	33·7
	Total	1676	23·1
From unsprayed cotton at Shemi	13 Nov.-28 Nov.	1410	37·7
	29 Nov.-24 Dec.	1483	24·1
	Total	2893	30·7

Observations on parasitized cells have shown that the parasite escapes from the pupal cell by the following method. After leaving its host within the cell, and before formation of its puparium, the parasite excavates a small 'exit pit' in the wall of the cell. Pupation then takes place with the anterior end of the puparium lying close to the pit. In this condition a cell containing a parasite can often, but not always, be distinguished externally by the presence of a pin-sized hole at one end, where the exit pit has broken through to the outside. When the fly leaves the puparium, it pushes through the weakened cell wall at the exit pit (Reed and Choyce, 1961).

Sowing Date of Cotton

Yields from a date-of-sowing trial at Samaru are given in Table 7. There was an almost linear fall in yield, at the rate of 174 ± 9·1 lb per acre per week, from the first sowing onwards. In previous trials, early June sowings have not always outyielded late June sowings, but it is probable that they would normally do so, given sufficient moisture for germination, adequate pest control and good growing conditions throughout the season.

TABLE 7

COTTON DATE-OF-SOWING TRIAL, SAMARU, 1960

Fertilizer: 2 cwt single superphosphate plus 2 cwt sulphate of ammonia per acre.

Insecticide: 10 sprays at weekly intervals beginning 9 weeks after sowing; 2 lb DDT plus 0·2 lb gamma BHC per acre per application.

Sowing date	*Yield of seed cotton (lb per acre)*
3rd June	1,939
10th June	1,847
17th June	1,701
24th June	1,429
1st July	1,214
8th July	1,071
15th July	955
22nd July	784

The recommended sowing date for unsprayed cotton throughout Northern Nigeria is the beginning of July, since it has been clearly established, at least in the main cotton growing areas, that a progressively lower yield is obtained from later sowings. It is possible that this may not be true if the cotton is subjected to a very heavy pest attack, such as might occur in the riverain areas of Nigeria.

At Mokwa, five plots of cotton were sown during each of the following periods:—14th to 18th June (early); 5th to 9th July (normal); 26th to 30th July (late). Each plot was a quarter acre in area, and was separated from its neighbours by at least one hundred yards to minimise cross-interference by pests. Mean yield of seed cotton and the weight of the plant framework taken after harvest, for each period of sowing, are given in Table 8.

TABLE 8

COTTON YIELDS FROM VARIOUS SOWING DATES, MOKWA, 1960

Fertilizer: ½ cwt single superphosphate plus ½ cwt sulphate of ammonia per acre.

Insecticide: Nil.

Sowing dates	*Seed cotton (lb per acre)*	*Plant framework (lb per acre)*
Early—14th to 18th June	238	1896
Normal—5th to 9th July	270	1724
Late—26th to 30th July	358	1204
S.E.	±39·4	

There was a wide range of yields from the five plots in each sowing period, but the linear increase in yield with later sowing is significant. This may have been a seasonal effect due to a heavy stainer and bollworm attack early in the season. The weight of the plant framework indicates that the potential yield of the late July sowings was less than that of the earlier sowings. Further trials must be carried out before any alteration in the general recommendation on sowing dates can be considered, as these must be based on the average results over a number of seasons.

Cotton Seed Multiplication

Stage B and part of stage C multiplication cotton, totalling 283 acres, were sown on Daudawa main farm from 16th to 23rd June. Five applications of insecticide (1 lb DDT plus $\frac{1}{10}$ lb gamma BHC per acre per application) were completed between 22nd August and 15th October. An area of 120 acres which had received fertilizer at the rate of 1 cwt single superphosphate plus 2 cwt sulphate of ammonia per acre yielded 822 lb per acre. A further area of 130 acres, with 1 cwt single superphosphate and ½ cwt sulphate of ammonia per acre, yielded 673 lb per acre. Growing conditions during the season were good, and

over a third of the crop on the main farm gave over 900 lb per acre. The yield from 150 acres of Stage C cotton at Shemi was 470 lb per acre; this area was not sprayed.

Recommendations intended to increase the efficiency of cotton growing at Daudawa have been made. These have been based on the improved methods of cotton growing evolved at Samaru and Daudawa during the past four years.

Insecticide Trials at Samaru

(a) *Time of application of insecticide.*—Yields from cotton receiving a series of six sprays at weekly intervals starting 7, 9, and 11 weeks after sowing are given in Table 9. Significantly higher yields were obtained with the later sprays.

TABLE 9

COTTON TIME OF APPLICATION OF INSECTICIDES, SAMARU, 1960

Layout: 4 replications of 4 treatments; plot size 1/14 acre.
Fertilizers: 2 cwt single superphosphate plus 2 cwt sulphate of ammonia per acre.
Sowing date: 20th June.
Insecticide: 1 lb DDT plus 1/10 lb gamma BHC per acre: 6 sprays at weekly intervals.

Date of first spray	*Yield of seed cotton (lb per acre)*
8th August—7 weeks after sowing	1173
22nd August—9 weeks after sowing	1317
5th September—11 weeks after sowing	1337
No sprays	878
S.E.	±68·3

(b) *Bollworm control.*—Details of a test of various insecticides for bollworm control are given in Table 10. These insecticides were applied during the main *Diparopsis* flight, which, in 1960, extended from the second half of September into October. In September, before the actual treatments were made, the whole trial was sprayed with gamma BHC to reduce interference from cotton stainers and mirids.

Although overall yields were good, the results of the trial are inconclusive, because bollworm infestation never reached a high level. In bud and boll samples taken on 4th, 10th and 17th October, for example, only 15 per cent of the more mature bolls on the control plots were damaged by bollworm. This was reduced to 7 per cent on those plots treated with sprays containing 1 lb Sevin per acre.

In this trial, the proportion of small mummified bolls on plots treated with 1 lb Sevin per acre was similar to the proportion on the control plots. This evidence is in favour of the view that these bolls, which are formed from October onwards, are the result of physiological changes within the plant (induced by water-stress, for example) rather than by insects.

TABLE 10

BOLLWORM CONTROL TRIAL, SAMARU, 1960

Layout: 6 replications of eight treatments; plot size 1/19 acre.

Fertilizers: 2 cwt single superphosphate plus 2 cwt sulphate of ammonia acre.

Sowing date: 23rd June.

Insecticide: All plots: $\frac{1}{4}$ lb gamma BHC per acre on 25th August, 6th, 15th and 23rd September.
Treatments: applied on 29th September, 6th, 15th, 20th and 27th October.

Insecticide (Active ingredient per acre)	*Yield of seed cotton (lb per acre)*
$\frac{1}{2}$ lb Sevin	1653
1 lb Sevin	1730
1 lb DDT plus $\frac{1}{10}$ lb gamma BHC	1572
2 lb DDT plus $\frac{1}{5}$ lb gamma BHC	1721
$\frac{1}{4}$ lb endrin	1589
$\frac{1}{2}$ lb endrin	1608
$\frac{1}{2}$ lb Phosphamidon	1566
Control	1384
S.E.	±54·4

(c) *Use of a resin in cotton insecticides.*—Several new insecticide formulations, some containing the chlorinated wax, 'Cereclor', were tested on cotton to determine whether a resin of this type would be of value under field conditions. The results indicate that, in the formulations tested, 'Cereclor' did not increase the effectiveness of DDT and BHC against cotton pests (Choyce and Reed, 1961a).

Provincial Spraying Trials

Variable, but on the whole encouraging, results were obtained from provincial spraying trials. A specially formulated 'Cotton Spray Concentrate', containing 2 lb DDT plus 0·2 lb gamma BHC per gallon, was used. It was recommended that six weekly sprays, each containing half a gallon of the concentrate per acre, should be applied with a 'Lancet' sprayer, beginning nine weeks after sowing. In those trials in which a comparison is possible between sprayed and unsprayed cotton, the average increase due to spraying was about 300 lb seed cotton per acre. This quantity of Grade I seed cotton would give a profit of £3 after paying for insecticide and depreciation on the hand-sprayer. Where higher standards of cultivation and closer supervision were possible, yield increases were much higher. At Mokwa, for example, 10 acres of cotton sprayed with a hand-sprayer yielded 1308 lb per acre, and 35 acres sprayed with a 'Hi-boy' sprayer yielded 1018 lb per acre. Yields from unsprayed cotton at this station were less than 500 lb per acre.

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Appendix

Origin and main characteristics of cotton strains mentioned in this report

Allen	The local variety of the Northern Region up to 1953. Allen Long Staple, together with other strains, was introduced from East Africa in 1912.
Ishan	The variety grown in Western Nigeria: *Gossypium barbadense*.
Benue	An unselected mixture of Ishan and Allen, predominantly *G. barbadense*, grown in the riverain provinces of Northern Nigeria.
Samaru 26C	A selection from Allen made in 1939, with higher yield, higher ginning percentage and freedom from "nep".
26I	A sister strain of 26C.
26J	A derivative of 26C, from the line S48. Higher yielding and earlier cropping, with better spinning quality. Staple length 1″ to $1\frac{1}{16}$″.

S48	Previously known as 26C/479-25. Characteristics as for 26J above.
S49	Previously known as 26C/49160-23. Contains material of high spinning quality.
S51	A derivative of S48, previously known as 26C/479-25-97; a component of 26J. Good spinning and average yield.
S52	A derivative of S48, previously known as 26C/479-25-44; a component of 26J. High yielding but poorer spinning quality. Used in testing selection index.
S56	A derivative of S48, previously known as 26C/479-25BCP/14. Used to establish modal and positive bulks.
QA & QB	Mixtures of the best material available in 1961—see text.
BAR D28	A selection resistant to bacterial blight from a Gold Coast strain D28.
Maradi B	A selection made in Niger from "Zaria Allen" (Samaru 26C). Resistant to bacterial blight.
Punjab 268F	A strain of Upland cotton giving high yields in the Punjab. Susceptible to bacterial blight.

Received February 1962.

PROGRESS REPORT FROM EXPERIMENT STATIONS

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

1923-25 (one volume), 1926-27, 1931-32, 1934-35,
1935-36, 1942-43 and 1945-46 to 1950-51.

From 1951-52 the reports from each territory were published individually each season. A few of the 1951-52 reports are out of print, but all others are available post free at 2/6 per report or £1 for the seasonal set.

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